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J Clin Invest. 2021;131(6):e148012. <https://doi.org/10.1172/JCI148012>.

Viewpoint

As physician-scientists in training, so much of our education focuses on the technical aspects of science and medicine: performing experiments, analyzing data, and acquiring clinical knowledge and skills. However, the traditional scientific training that many of us undertake often overlooks the importance of communicating science to our peers as well as a broader audience. Although trainees are aware of the critical roles of peer review and publication to advancing science, few students are formally trained in how to make figures, write a manuscript, and successfully bring a research project to publication (1). Even for those among us who do master scientific writing, the steps required to publish often remain obscure. This gap in training has been recognized by editorial boards of several journals, leading some to develop programs that allow trainees to sit on their editorial boards and learn by experience (2, 3). As a journal at the intersection of basic science and clinical medicine, JCI established the JCI Scholar Program to introduce future physician-scientists to the mechanics of the editorial and publishing process. As JCI Scholars, we joined editorial board meetings during which members discussed the merits of manuscripts submitted to the journal. After we gained some experience, we were assigned manuscripts under the supervision of an associate editor who mentored us in reviewing manuscripts, identifying appropriate reviewers, and [...]

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As physician-scientists in training, so much of our education focuses on the technical aspects of science and medicine: performing experiments, analyzing data, and acquiring clinical knowledge and skills. However, the traditional scientific training that many of us undertake often overlooks the importance of communicating science to our peers as well as a broader audience. Although trainees are aware of the critical roles of peer review and publication to advancing science, few students are formally trained in how to make figures, write a manuscript, and successfully bring a research project to publication (1). Even for those among us who do master scientific writing, the steps required to publish often remain obscure. This gap in training has been recognized by editorial boards of several journals, leading some to develop programs that allow trainees to sit on their editorial boards and learn by experience (2, 3). As a journal at the intersection of basic science and clinical medicine, *JCI* established the *JCI* Scholar Program to introduce future physician-scientists to the mechanics of the editorial and publishing process.

As *JCI* Scholars, we joined editorial board meetings during which members discussed the merits of manuscripts submitted to the journal. After we gained some experience, we were assigned manuscripts under the supervision of an associate editor who mentored us in reviewing manuscripts, identifying appropriate reviewers, and formulating editorial suggestions before ultimately presenting each one to the board for discussion. The *JCI* editorial board is unique in that the editors are active leaders in research, and

their labs have made major contributions to their respective fields. This offers those who serve as *JCI* Scholars a window into the perspectives of individuals who are simultaneously academic editors and eminent physician-scientists. Here, we write to share how our tenure as *JCI* Scholars has affected our training and future plans in hopes that our experiences may be helpful to our fellow young physician-scientists in shaping their careers.

Learning to identify scientific questions

In our earliest board meetings, we immediately noticed that the clinical problem a manuscript addressed was one of the most important criteria in deciding whether a story would progress along the editorial pipeline. When discussing a manuscript, editors would first orient the board to the clinical problem at hand and how the study being discussed tackled it, such as uncovering the molecular mechanism underlying its pathogenesis or identifying novel therapies. It was clear that studies without a solid grounding in human physiology or disease were less compelling to the board, not because they were unimportant, but because the *JCI* prioritizes work with clear implications for clinical medicine. As aspiring physician-scientists, this underscored the value of our training and the privilege we will soon hold in straddling both science and medicine. By leveraging our training, we will be empowered to identify and solve critical problems directly at our patients' bedsides, such as drugs with unknown mechanisms and diseases with unknown pathogenesis. In discussing a multitude of diverse research projects,

we also gained more confidence that what we all hope — that answering important clinical questions with rigorous and careful experimentation can actually improve clinical practice — is attainable and true. This was particularly instructive for us as physician-scientists in training, as reading these studies can provide us with direction and inspiration as we move towards our ultimate goals of growing our own research programs.

As we move forward in our formal clinical training, our time as *JCI* Scholars has thus taught us to pause and reflect when we learn of unclear or ambiguous biological mechanisms. What has obfuscated our understanding of these processes? Which clinical problems have remained unanswered due to a lack of basic scientific exploration into them? We have also resolved to actively remember the underserved patients that we encounter. Our time as *JCI* Scholars demonstrated on multiple occasions that these patients are some of those that our science may be able to affect and help the most, and it would be truly gratifying to help the promise of science reach these more vulnerable populations.

Learning to answer scientific questions

Especially profound during our tenure as *JCI* Scholars was the opportunity to discuss studies that implemented creative, thoughtful, and exciting experimental approaches. The most compelling manuscripts incorporated technical details and thorough experimental designs in ways that bridged the bench-to-bedside gap, most commonly by including experiments with human tissue or samples from patients. Again, we found that our extensive training in both research and clinical medicine empowers us to pursue similarly comprehensive studies. Our graduate research training provides us experience with an

Authorship note: CV and OU contributed equally to this work

Conflict of interest: The authors have declared that no conflict of interest exists.

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Reference information: *J Clin Invest*. 2021;131(6):e148012. <https://doi.org/10.1172/JCI148012>.

empirical toolbox, including such diverse methods as Western blots, next-generation sequencing, knockout mice, and ever-advancing imaging modalities. In addition to being armed with these laboratory techniques, we are also uniquely positioned to identify and recruit patients ourselves. With their consent, their generously donated samples or tissues can be used to directly probe human pathology and the underlying mechanisms responsible. Bridging the physician and scientist roles in these ways will allow us to evaluate a syndrome or disease in the clinic and then explore it in a testable model in the lab.

Many of our discussions with mentors and in the editorial board meetings also centered on the authors' experimental approaches. At the forefront of reviewers' concerns was whether the authors considered the appropriate controls. In many experiments, the number of controls would outnumber experimental samples and would lay the groundwork for some of the most compelling and elegant experiments. These controls complemented and strengthened the array of methods authors used to answer their experimental questions. Studies that approached a scientific question with a singular method or with minimal controls were generally unconvincing. In contrast, studies that effectively combined different techniques often led to novel findings that advanced the field's knowledge. The latter often fared much better through the editorial process, underscoring the value in being competent in diverse experimental techniques.

Learning to be a broadly competent scientist

Just as a broad medical knowledge base helps develop the most comprehensive differential diagnosis, the best manuscripts we encountered addressed their scientific questions from several different angles, often considering and preempting alter-

native hypotheses. To fully appreciate the multidisciplinary approaches these manuscripts addressed, we often found ourselves absorbed in significant background reading. We sought to understand how the manuscript fit into the field more broadly, whether it helped resolve open controversies or whether it challenged the current dogma. Our mentors were essential in helping us comprehend a manuscript's translational potential and how it built upon current knowledge. We also dedicated time to understanding the benefits and drawbacks of unfamiliar techniques in order to discuss the submissions intelligently with our mentors and appropriately interpret the results.

Evaluating manuscripts taught us the value of carefully pushing the boundaries of our scientific expertise. We saw that bringing a novel and diverse approach to an old, dogmatic question can yield breakthroughs and exciting knowledge. For some of us in training, it may then be worthwhile to seek out research-track residencies that provide protected time to learn new concepts as we refine our research careers. For others, it may just be enough to become more comfortable delving into fields that are new to us with the support of mentors and collaborators.

Progress does not occur in isolation

In addition to the practical skills that we honed throughout the *JCI* Scholar Program, our tenure emphasized to us the importance of forging relationships with mentors at all stages of training. Although our experience was virtual due to the COVID-19 pandemic, our mentors interacted with us as often as needed, whether it be by phone, email, or video call. Their willingness to answer our questions, both professional and personal, was invaluable in helping us synthesize our experiences and formulate training goals moving forward.

JCI board meetings further reinforced the value of fostering an expanding circle of mentors, colleagues, and collaborators. Each meeting was a case study in the benefits of building wide networks beyond our own scientific or clinical disciplines. Although a manuscript might be assigned to a specific editor because of their expertise, the handling editor would always reach out to fellow board members to ask for their thoughts on the manuscript at hand. The advantages of these networks cannot be understated, and the professional relationships we build through our careers will provide rich support that will ultimately allow us to forge stronger collaborations, answer scientific questions in multidisciplinary ways, and improve the care of our future patients.

Acknowledgments

The authors would like to acknowledge Laszlo Nagy, Akrit Sodhi, and Stuart Ray for their dedicated mentorship through the *JCI* Scholars Program. The authors also thank Rexford Ahima and Sarah Jackson for their leadership and for pioneering the *JCI* Scholars Program. This work was supported by NIH grant T32 GM136577 (to CV).

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